REVIEW ARTICLE

Standardized Prehospital Treatment of Stroke

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SUMMARY

Background: The lack of standardized pre-hospital treatment is a weak link in the care of acute stroke patients.

Methods: Selective review of the literature on acute stroke, with consideration of current guidelines in Germany and other countries (DGN, ESO, AHA/ASA).

Results: The mandatory, immediate transfer of acute stroke patients to a specialized stroke unit is supported by high-level evidence. Simple, sensitive screening tests for the diagnosis of stroke are available that can be performed in the field by trained non-physician emergency medical personnel. With regard to pre-hospital treatment, adequate scientific evidence supports cardiopulmonary stabilization, as well as oxygen supplementation if there are signs of hypoxemia. The patient's neurological findings, time of onset of symptoms, current medications, and past medical and surgical history must all be precisely and thoroughly documented. The receiving hospital must be informed of the patient's impending arrival as early as possible, particularly in cases where recanalizing procedures are still a therapeutic option. Treatment with aspirin or heparin must not be started in situ, i.e. without prior cerebral imaging.

Conclusion: In the pre-hospital phase of stroke care delivery, the goal of a high capture rate can best be achieved through the use of appropriate diagnostic tests with maximal sensitivity. Patients with suspected acute stroke should be given the highest priority for transfer to a specialized stroke unit. Optimal pre-hospital care requires the smoothly functioning cooperation of all professionals involved, from the triaging and nursing personnel to the paramedics, dispatchers, emergency physicians in the field, and admitting physicians in the hospital.

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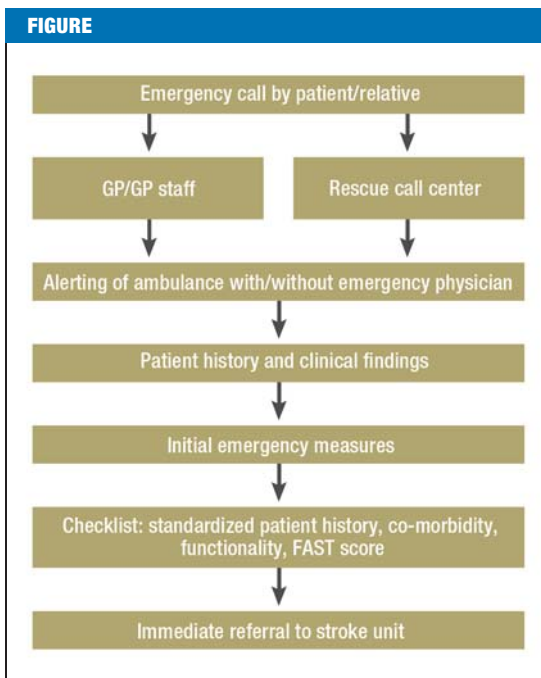
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Stroke is an important acute disease. Health economics require comprehensive care of stroke patients. In the acute phase of ischemic stroke, systemic thrombolysis currently represents the sole therapeutic option which is supported by evidence and meets both medical and drug-law requirements (1). This treatment requires a very tight time interval between onset of the incident and thrombolysis ("time is brain") (2, 3). It was however also shown that even patients who do not undergo thombolysis benefit from treatment in a stroke unit ("competence is brain") (4–6). The German Society of Neurology (Deutsche Gesellschaft für Neurologie, DGN) and the German Stroke Society (Stiftung Deutsche Schlaganfallgesellschaft, DSG) have developed a guideline for the acute therapy of stroke (1). Institutions who wish to be recognized as certified stroke units by the German Stroke Society and the German Stroke Foundation (Deutsche Schlaganfallhilfe, SDSH) are required to have standard operation procedures (SOP) in place that have been adapted to local conditions. However, comparable guidelines for SOPs in the prehospital phase of stroke are currently still lacking.

The prehospital phase is defined as the interval between the onset of stroke and hospital admission. Successful acute therapy in a stroke unit is based on a structured approach which begins before the patient reaches the hospital. This structured approach ensures:

- a shorter instruction period
- optimal documentation of patient history, time of incident, concomitant medication, comorbidity, and surgical interventions.

In the following article, we present the findings of the working group "Prehospital Phase" of the German Stroke Society.

Methodology

A literature research of PubMed was conducted using the search terms "prehospital stroke", "prehospital stroke care", "stroke screening tool" and "emergency service stroke". The authors reviewed the abstracts and, where relevant, analyzed the corresponding article. The analysis was confined to randomized controlled studies with clinically relevant endpoints (mortality, permanent disability, need for care, neurologically measurable changes) or, failing that, prospective observational studies with balanced cohorts. The key messages of these studies were assessed by grading them according

Key points of
prehospital stroke
treatment

FIGURE

Emergency call by patient/relative

GP/GP staff

Rescue call center

Alerting of ambulance with/without emergency physician

Patient history and clinical findings

Initial emergency measures

Checklist: standardized patient history, co-morbidity, functionality, FAST score

Immediate referral to stroke unit

BOX

Classification of evidence and strength of recommendation*[1]

- **Evidence**
  - **Class I:** adequately powered randomized controlled trial with blinded outcome assessment in a representative population, or an adequately powered systematic review of prospective, randomized, controlled clinical studies with blinded outcome assessment of representative populations
  - **Class II:** prospective matched cohort study in a representative population with blinded outcome assessment
  - **Class III:** controlled studies (incl. well defined controls with untreated course or with intra-individual comparison) in a representative population, in which outcome is assessed regardless of treatment
  - **Class IV:** evidence from uncontrolled studies, case series, single case reports, or expert opinion

- **strength of recommendation**
  - **A**   demonstrably effective, not effective or harmful
  - **B**   probably effective, not effective or harmful
  - **C**   possibly effective, not effective or harmful
  - **GCP** no class I to III scientific evidence or only inconsistent findings available; customary best medical practice, in consensus with experienced physicians

*[1]modified in accordance with the European Federation of Neurological Societies

to one of the four classes of evidence in compliance with the classification of the European Federation of Neurological Societies (EFNS) (*Box*) (7). The guidelines on ischemic stroke of the German Society of Neurology, the European Stroke Organisation and the American Stroke Association/American Heart Association were also taken into consideration in the phrasing of the clinical recommendations.

identification of a stroke patient by medical/non-medical staff

Both ambulance call center staff and the primary care team, either of whom might field the initial call, must be able to determine as accurately as possible whether the reported event represents a stroke with a high urgency for hospitalization (evidence class II) (8–12). *Table 1* shows the standardized filter questions that staff at the rescue center (dispatcher) must put to the caller. Staff must receive adequate training.

Stroke patients must be transported to a stroke unit without delay (evidence class 1). Whether or not the individual situation requires an accompanying emergency physician is decided by the emergency medical service on the basis of the recommendations of the German Medical Association (13). The obligatory question is: When did the neurological symptoms set in, or when was the last point in time the patient remembers not having had the symptoms? The less time has passed since the onset of symptoms, the larger the potential therapeutic benefit (evidence class I) (2, 3), and the more urgent the need for hospitalization.

Keywords such as sudden-onset paralysis, acute impairment of speech or vision, severe, sudden-onset headache and loss of vigilance must be viewed as red flags that indicate immediate transfer to a hospital with a stroke unit (evidence class I), bypassing day time or after hour primary care services (3). This recommendation is based on consistent, reproducible findings from meta-analyses demonstrating the positive effect of care on a stroke unit. Several studies have shown significantly improved prognosis with shorter transfer time between onset of stroke symptoms and initiation of thrombolytic therapy (3, 12). A Cochrane meta-analysis from 2007 found

- a 14% reduced chance of death after stroke (event rate 22.5% versus 26.6%; absolute risk reduction [ARR] 4,1%; odds ratio [OR] 0,83; 95% confidence interval [CI] 0.71–0.96; p = 0.01),
- an 18% reduced chance of death or admission to care facility (event rate 36.4% versus 41.8%; ARR 5.4%; OR 0.80; 95% CI 0.70–0.90; p = 0.0005),
- an 18% reduced chance of death or care dependence (event rate 53.0% versus 56.5%; ARR 3.5%; OR 0.83; 95% CI 0.72–0.96; p = 0.01) due to initial care on a stroke unit (8).

Subgroup analyses showed no age (</>75 years), sex or severity related differences in the effect of stroke unit treatment. The pooled analysis of thrombolysis studies showed a decrease of OR for a good functional

TABLE 1

Instructions for emergency staff and rescue center staff

Identifying a stroke patient

Staff at the hospital control center or GP office should suspect stroke when given the following statements:

Sudden onset of:
– paralysis (hemiplegia or hemilateral paralysis of an extremity, atraumatic tetraparesis, facial paralysis, mouth droop)
– visual impairment (e.g. double vision, hemilateral blindness, scotoma)
– speech disorders
– gait disorders
– for the first time sudden onset severe headache
– hemilateral sensory disturbances (numbness, paresthesia)
– acute vertigo, even though this symptom is ambiguous in combination with any of the other symptoms
– loss of vigilance (persistent or progressive)

Always ask: When was the last point in time the patient did not exhibit the new symptoms? (time given should be as exact as possible)

Questions	Answer	How to proceed
1: Is the patient awake?	No	Immediate ambulance service with emergency doctor
	Yes	Immediate ambulance service; whether or not an accompanying emergency physician is required is decided by the rescue service
2: Occurence of acute paralysis? (arms, legs, mouth droop)	If at least one question is answered with Yes:	Immediate ambulance service; whether or not an accompanying emergency physician is required is decided by the rescue service
3. Occurence of acute speech disorders? (muffled speech, slurring, garbled speech, word finding difficulty, patient does not understand other people)		
4. Occurence of acute visual impairment? (double vision, hemilateral blindness, scotoma)		
5. If headache: has it appeared for the first time and is it acute and severe?		
6. Hemi- or unilateral sensory disturbances (face, arm, leg)		
7. Acute vertigo?		

result after three months from 2.81 (95% CI 1.75–4.50) in the group of patients thrombolyzed within 90 minutes for every 90-min latency to a non-significant 1.15 (95% CI 0.90–1.47) in the group treated within 271 and 360 minutes (14).

Check list and FAST test on the ground

Front line emergency staff should note the onset of symptoms and their development (spontaneous improvement, worsening, stability of symptoms) and also register potential contraindications to thrombolysis. This will facilitate the decision-making process of the specialist at the stroke unit regarding thrombolysis. Important contraindications include:
- malignant diseases
- surgery in the last three months
- invasive procedures (punctures) in the last four weeks
- earlier hemorrhagic events
- existing anticoagulant therapy
- known coagulation disorders.

Several validated tests are available for standard stroke screening, which can also be used by non-

medical personnel (evidence class II) (10–12, 15). As these tests have a false-negative rate of at least 5%, a negative test result does not exclude stroke with all certainty. In Europe the FAST test (face–arm–speech–test) is increasingly used, a variation of the Cincinnati Prehospital Stroke Scale (*Table 2*). A comparative study found this screening instrument to have the highest sensitivity of 95%, but with the disadvantage of a low specificity of 56% (15). However, since the goal is to administer thrombolysis to as many patients as possible, maximum sensitivity takes priority in this case.

Specific training is required for the correct and reliable application of the FAST-test. The items of the stroke checklist for front line emergency staff are listed in *Table 2*.

Practical procedures before and during transport

Every stroke patient who can be treated within six hours after symptom onset at a hospital with stroke unit expertise is, in principle, a candidate for thrombolysis or any form of endovascular intervention, provided

TABLE 2

Stroke-checklist for front line emergency staff on the ground

Emergency care on the ground: three steps			
1. Securing and stabilizing vital functions	According to ABC In addition in every patient: – measuring of capillary oxygen saturation – blood sugar quick test		

2. History	As reported by the patient and friends / relatives / other witnesses:
	
	time of symptom onset or last point in time of being free of symptoms
	– in case of <6 hours: potential thrombolysis candidate
	– symptom development:
	  Improvement? Worsening? Stable symptoms?
	– previous diseases, in particular severe diseases within the last three months (e.g. surgery in the last three months, punctures in the last four weeks)
	– concomitant medication, especially anticoagulants or platelet aggregation inhibitors
	– phone no. of relatives
	
	– level of care:
	  – patient was independent before event
	  – patient was continuously bedridden before event		

3. FAST	facial paralysis	both sides of the face move symmetrically	normal
		a paralyzed face is droopy on one side	pathological
	Arm drift	both arms move symmetrically or not at all	normal
		One arm drifts compared to the other	pathological
	Speech / talking	Patient uses correct words, speech not slurred	normal
		Patient has slurred speech or uses wrong words or does not talk at all	pathological
	If one of these points is pathological the presence of stroke is highly likely		

TABLE 3

Therapeutic measures on the ground and during transport

Emergency treatment on the ground		
All patients	– Peripheral venous catheter, if possible not in the paretic arm – upper body elevation – if hypoxemia 4L/min nasal oxygen (target value saturation >95%) (caution: no oxygen in COPD patients) as contraindicated in intracranial hemorrhage or thrombolysis: no antithrombotics (heparin or aspirin lysine IV, no i.m. injections)	
Arterial hypertension	– BP sys ≤ 220 mm Hg – BP dia ≤ 120 mm Hg	leave
Hypertensive values in 2 measurements of 5-min interval	– BP sys > 220 mm Hg – BP dia > 120 mm Hg	– urapidil in 10- or 12.5 mg steps fractionated IV – captopril 6.25–12.5 mg IV – metoprolol in 5–10 mg steps IV
	Several antihypertensive drugs that are indicated in the treatment of other hypertensive decompensations should be avoided in stroke patients and/or only be used in refractory hypertension: nitrate SL, calcium channel blocker of the nifedipine-type SL or IV	
Arterial hypotension	– BP sys ≤ 120 mm Hg (no signs of heart failure)	500 mL electrolyte solution or NaCl 0.9% IV
Hypoglycemia	<60 mg/dL (<3.3 mmol/L)	30 mL glucose 20% to 40% IV
Hyperglycemia	≥ 200 mg/dL (11 mmol/L)	additional glucose-free fluid intake
Complications and underlying diseases	– heart failure – respiratory insufficiency – aspiration	Individual decision according to severity

there are no obvious contraindications (evidence class II–III) (2, 16–19). It is vital that the responsible stroke team is given notice by phone of the thrombolysis candidate; this also helps to save additional time (evidence class III) (20).

Regarding the actual time frame of the prehospital phase there are a number of studies covering various nations and regions with very different socioeconomic levels of development and a wide range of healthcare systems and structures. A comprehensive global meta-analysis showed a wide range of the share of patients with a prehospital phase of <3 hours between 6% and 92%, with a median latency of approximately 3 hours in the year 2005 compared to approximately 6 hours in the year 1995, before the approval of rt-PA (recombinant tissue plasminogen activator) in the US (21). German data show a median prehospital phase of 151 minutes and a share of 54% of patients reaching the hospital in <3 hours (22).

There is only little evidence based data on practical procedures before and during transport. Most of the information provided here is based on extrapolation from acute care in a stroke unit.

All patients require a peripheral venous catheter. If at all possible, the catheter should not be placed in the paretic arm, so as to avoid impaired fluid distribution and increased complications in the case of extravasation in the paretic extremity (evidence class IV).

Should signs of hypoxemia appear—i.e. clinical signs or peripheral oxygen saturation of <95%—the treatment consists of 4 L/min nasal oxygen (target value >95%, evidence class IV for prehospital application). According to pilot studies this approach ensures a survival benefit for patients treated with oxygen immediately after admission (OR 0.45, 95% CI 0.23–0.90; p = 0.023) (evidence class III) (23). Furthermore, patients treated with oxygen due to hypoxemia had a lower infarct volume in diffusion-weighted MRI (24). Routine oxygen administration is not indicated (evidence class IV).

The patient should recieve cardiovascular stablilization before transport. Hypertension should be treated if blood pressure exceeds 220 mm Hg systolic or 120 mm Hg diastolic (1) (evidence class IV). Electrolyte solutions or normal saline are indicated in arterial hypotension RR systolic below 120 mm Hg (evidence class IV) (25, e1), keeping in mind possible contraindications (severe heart failure). In hypoglycemia below 60 mg/dL (<3.3 mmol/L) the administration of 30 mL 20% to 40% glucose IV is recommended (evidence class IV). In hyperglycemic patients—above 200 mg/dL (>11mmol/L)—an adequate liquid intake is of particular importance (evidence class IV) (e2, e3). Note: No antithrombotic or platelet aggregation inhibitors must be administered until the results of cerebral imaging have differentiated between an ischemic infarction and cerebral hemorrhage.

Table 3 lists the most important therapeutic measures on the ground and during transport.

Handover at the hospital

It is the responsibility of the emergency team to hand over any information gathered in the prehospital phase to the hospital team providing further treatment (evidence class IV). The following information should be communicated in a structured, brief handover:

- time of symptom onset or last point in time without the new deficit
- type of complaint
- relevant concomitant diseases
- information regarding pre-morbid state
- phone number of relatives for immediate contact regarding detailed patient history
- current medication.

One criterion of a successful stroke unit is a well-structured prehospital phase. The main aim should be efficient organization so as to minimize the time window between stroke event and hospital admission.

Professor G. F. Hamann from the department of Neurology at the Dr.-Horst-Schmidt-Kliniken (HSK), Wiesbaden, has contributed to preparation of the Manuscript.

KEY MESSAGES

- The effective treatment of acute stroke within a stroke unit requires the minimization of the prehospital phase.
- Clinical screening tests that are both easy to learn and to implement allow the selection of stroke patients. The next step is the immediate emergency transport to a stroke unit, where appropriate without an emergency physician.
- The aim is initial care in a stroke unit. This has been shown to increase survival and reduce complications regarding nursing care.
- The standard collection of basic data on the ground, if possible with the help of relatives / witnesses, is crucial for adequate further treatment in a stroke unit.
- Unlike interventions in the acute hospital phase, few therapeutic and diagnostic interventions in prehospital care are as yet evidence-based. Further research in this area is urgently needed.

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